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Discrete Address Beacon System (DABS), Proposed U.S. National Aviation Standard

DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

Discrete Address Beacon System (DABS); Proposed U.S. National Aviation Standard

AGENCY: Federal Aviation Administration (FAA), DOT.

ACTION: Notice of Proposed National Aviation Standard.

SUMMARY: This action proposes a U.S. National Aviation Standard for the Discrete Address Beacon System (DABS). The standard would define the system and the performance characteristics of its components. It is intended to satisfy overall operational needs and assure compatibility with elements of the National Airspace System (NAS). While not regulatory, the standard may provide the basis for later rulemaking affecting airborne navigational equipment.

DATES: Comments must be received on or before April 21, 1980.

ADDRESS: Director, Systems Research and Development Service, Attn: ARD–10, Federal Aviation Administration, Department of Transportation, NASSIF Building, 400 7th Street, SW., Washington, D.C. 20590.

FOR FURTHER INFORMATION CONTACT: P. D. Hodgkins, ARD–201, Communications and Surveillance Division, Systems Research and Development Service, Federal Aviation Administration, 400 7th Street, SW., Washington, D.C. 20590; Telephone 202–426–8672.

History

The "Proposed U.S. National Aviation Standard for the Discrete Address Beacon System (DABS)" was previously published for public comment in the March 27, 1978 **Federal Register** (43 FR 12816). Since that time, the DABS National Standard has been extensively revised. Changes to the standard fall into five categories: editorial, RF waveforms, format rationalization, protocol, and DABS transponder changes. These changes are outlined below under the heading "CHANGES IN PROPOSED STANDARD."

Description

The Discrete Address Beacon System is an important element of the Upgraded Third Generation Air Traffic Control System. It is a fully compatible evolutionary upgrading of the Air Traffic Control Radar Beacon System (ATCRBS) currently deployed. It provides the improved surveillance and data link communications required to support the automation which will be provided by the Upgraded Third Generation Air Traffic Control System and enhanced developments of future Air Traffic Control (ATC) automation. DABS has been under development since 1972.

Definition of U.S. National Aviation Standard

U.S. National Aviation Standards are system standards embodying descriptions of system characteristics. They are issued by the Administrator of the Federal Aviation Administration (FAA), Department of Transportation (DOT). They describe the performance characteristics (the technical parameters, tolerances and techniques) of major elements of the system to the extent necessary to assure proper operation and interface compatibility between elements of the National Airspace System (NAS). U.S. National Aviation Standards generally are limited to cooperative air-to-ground subsystems involving government owned ground equipment and private airborne equipment. For example, the ATCRBS National Standard describes those performance characteristics of the ground and airborne components necessary to assure effective operation of radar beacon carried by military and civil aircraft as effective elements of national air traffic procedures. U.S. National Aviation Standards are not equipment specifications or standards pertaining to planning, programming, component equipments, siting, installation, availability, reliability, or maintainability.

Relationship of U.S. National Aviation Standard to Federal Aviation Regulations

U.S. National Aviation Standards issued by the Administrator in agency orders are binding only on FAA organizational elements. They establish the technical base and description of the NAS and component subsystems. Since they are not promulgated as Federal Aviation Regulations by the rulemaking process prescribed by 5 U.S.C. 533, they are not regulatory standards imposing duties on the public. With respect to the public, such standards are only advisory and their issuance is not rulemaking. However, while they are not regulatory, U.S. National Aviation Standards may serve as the basis for subsequent rulemaking actions. Because of the relationship between U.S. National Aviation Standards and possible subsequent regulatory actions, FAA publishes such standards in the **Federal Register** and solicits public comment prior to their approval by the Administrator.

Invitation of Public Comment

Interested persons are invited to submit written comments on this proposed U.S. National Aviation Standard, on or before April 21, 1980. Communications should be submitted in duplicate to: Director, Systems Research and Development Service, Attn: ARD–10, Federal Aviation Administration, Department of Transportation, NASSIF Building, 400 7th Street, SW., Washington, D.C. 20590. Copies of comments received will be available for examination in Room 7210 at the same address.

Changes in Proposed Standard

The following is an outline of the five categories of changes noted above under the heading "HISTORY." This outline should not be considered an all inclusive list of changes.

1. *Editorial changes.* The Standard has been reorganized into distinct and well defined sections. The revised standard has been written solely as a document which defines the characteristics of the DABS equipment and signals and not as a technical specification.

2. *Changes in RF waveforms.* Changes to the RF waveforms have been made in two areas. The P_4 pulse used in the ATCRBS/DABS All-Call interrogation has been lengthened and relocated to prevent false All-Call decodes due to mulipath on the interrogation link. The sync phase reversal has been moved from a position 0.5 microsecond after the start of the data block to a position 1.25 microsecond after the start of the data block. The purpose of this change is to permit a lower cost realization of the DPSK demodulator using phase locked loops and to make the sync phase reversal less susceptible to curruption due to echoes of the preamble pulses and the leading edge of the data block.

3. *Format rationalization.* The formats i.e., bits patterns, of DABS uplink and downlink transmissions have been redefined to make better use of the coding space available. The new system emphasizes bit group patterns rather than dedicated bits. Each transmission format on either the up or the downlink consists of three parts: the format identifier, the information space and the address/parity indicator. The address/parity fields remain at their original location at the end of the transmission and retain the 24-bit configuration. Between the format identifier and the address/parity field, either 27 or 83 bits are available which form the information space. The content of the

information space is defined by the format identifier.

4. *Protocol changes.* Some improvements have been made to the DABS surveillance and data handling protocols. A new BCAS squitter format has been adopted. An ordinary surveillance reply is now used instead of a dedicated squitter reply format so that BCAS equipment can acquire the address of a DABS transponder by listening to its replies to ground or BCAS interrogations. The transponder need only transmit a squitter if it has not replied to a DABS ground or BCAS interrogation within the last second. This change also makes it possible for the BCAS unit to determine the full 12-bit altitude code of the transponder from the squitter. Previously, the squitter format only had space for a truncated 6-bit altitutde code.

Provision has been made for the transmission of a 12-bit metric altitude code by the DABS transponder. The "M" bit in the altitude field is used to distinguish between the existing altitude code and the new metric code.

A means has been provided for discretely identifying the sensor which transmits the DABS-only All-Call interrogation. This is accomplished by means of a 4-bit code in the DABS-only All-Call interrogation and in the resulting All-Call reply. The code is overlaid on the parity field in the All-Call reply and does not affect the coding space within the body of the reply.

A protocol has been added for handling acquisition lockouts and clearing Comm-B and Comm-D transactions in and environment consisting of a number of independent sensors with overlapping coverage (multi-site environment). This protocol assures that each sensor in such an environment has equal and unrestricted access to each of the DABS transponders within view.

A change has been made to the procedure for resetting the "Alert" bit which is used to request that the ground read out the transponder 4096 code rather than the altitude code. Previously, this bit was reset by the ground. It is now reset by a timer to give additional sensors an opportunity to read it in a multi-site environment.

The ELM closeout protocol has been changed to allow the ELM transaction to be terminated by a message in a standard suveillance or Comm-A interrogation. Formerly, it was necessary to dedicate an entire Comm-C transmission for this purpose.

A probabilistic technique has been added for reducing the incidence of synchronous garble on All-Call acquisition. This "Stochastic Acquisition" technique replaces the "Specific Acquisition" scheme used in the previous version of the Standard. A protocol has been added to provide for the exchange of Conflict Indicator Register (CIR) data. This data is used for Aircraft Separation Assurance purposes.

5. *DABS transponder changes.* The revised Proposed DABS National Standard defines the transponder antenna system, when installed on an aircraft, to provide useful receive and transmit gain throughout a minimum coverage region in order to enhance their performance as BCAS remitters.

The transmitter power levels for DABS transponders are identical to those defined in the ATCRBS National Standard. Previously, the Proposed DABS Standard did not allow for reduced power in transponders which operate at altitudes below 15,000 ft.

The transponder MTL definition has been changed so that the tolerance range on the minimum triggering level for DABS interrogations lies within the tolerance range on the minimum triggering level defined in the ATCRBS National Standard. The previous version of the DABS Standard defined inconsistent MTL tolerances.

The performance of the DABS transponder in interference is now defined in the Standard.

The current version of the DABS National Standard explicitly states that a DABS transponder may include an uplink ELM capability without requiring downlink ELM capability. This point was not clear in the previous version of the Standard.

The DABS "Standard Message" interface is now defined in functional terms instead of detailed timing and electrical characteristics.

This notice is issued under sections 307(b) and 312 (a) and (c) of the Federal Aviation Act of 1958 (49 U.S.C. 1348(b) and 1353 (a) and (c)).

Issued in Washington, D.C., on February 27, 1980.

Martin T. Pozesky,

Acting Director, Systems Research and Development Service, ARD-1.

Proposed U.S. National Aviation Standard for the Discrete Address Beacon System (DABS)

February 21, 1980.

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U.S. National Standard for the Discrete Address Beacon System

1. General

1.1 System Features

1.1.1 The Function of DABS

The Discrete Address Beacon System (DABS) is an improved secondary radar system with an integral two way data link. DABS differs from the Air Traffic Control Radar Beacon System (ATCRBS) in the manner of selecting which aircraft will respond to an interrogation. In ATCRBS, the selection is spatial; in DABS, each aircraft is assigned a unique address code. Thus, an interrogator is able to limit responses to its interrogations to those targets for which it has surveillance responsibility, and to time the interrogations to ensure that the responses from DABS-equipped aircraft do not overlap. In addition, the discrete address provides the basis for a ground-air-ground digital data link. The main requirements of DABS are to:

a. Support automated air traffic control (ATC) with improved surveillance and communication capability and reliability in the projected 1995 traffic environment.

b. Permit evolutionary implementation at lowest user cost.

1.1.2 Rationale for the DABS National Standard

1.1.2.1 Legal Rationale

Under public law 85–726, the Federal Aviation Administration has the responsibility for the development and operation of a common system of air traffic control and navigation for both military and civil aircraft. Explicitly, the Administrator shall develop, modify, test and evaluate systems, procedures, facilities, and devices, as well as define the performance characteristics thereof, to meet the needs for safe and efficient navigation and traffic control of all civil and military aviation.

1.1.2.2 Technical Rationale

Systems selected for implementation as a result of these developments, modifications, test and evaluation efforts are described in U.S. National Aviation Standards. These are system standards embodying descriptions of system characteristics. They describe technical parameters and tolerances that ensure proper operation and compatibility between elements of the National Airspace System.

1.1.2.3 Conclusion

Optimum performance will be obtained if these System Characteristics are met by all users of the Discrete Address Beacon System under all expected operating conditions. Consequently, it is important to define many characteristics of the airborne components used in the system.

1.2 Coordination of DABS With the Air Traffic Control Radar Beacon System (ATCRBS)

1.2.1 ATCRBS Compatibility

To facilitate the transition from ATCRBS to DABS over an extended period, DABS installations, both ground and airborne, include full ATCRBS capability. DABS interrogators provide

surveillance of ATCRBS-equipped aircraft, and DABS transponders are capable of replying to ATCRBS interrogators. To accomplish this dual mode operation (ATCRBS and DABS) with minimum equipment complexity, DABS operates on the same interrogation and reply frequencies as ATCRBS.

1.2.2 Relationship Between DABS and ATCRBS National Standards

ATCRBS-only transponders are not affected by the DABS National Standard, and the ATCRBS-mode operation of DABS transponders adheres to the ATCRBS National Standard (Reference A) for Modes A and C.

1.2.3 ATCRBS IFF Mark XII System (AIMS) Compatibility

The DABS system has been designed for operational compatibility with AIMS including Mode 4.

1.3 Scope of This Standard

This National Standard defines the characteristics of the DABS signals, formats and protocols.

1.3.1 Items Not Covered

This Standard does not include specific data link message contents and codes. Such codes will be the subject of separate Standards.

1.4 Overall System Capabilities

1.4.1 Coverage

The DABS sensor will perform surveilliance of all beacon-equipped aircraft within its line-of-site coverage airspace. The nominal maximum range is 200 nmi, but is site adaptable to shorter ranges. ATCRBS-equipped aircraft are interrogated at the minimum rate that produces an adequate number of interrogations for azimuth determination. The addresses of DABS-equipped aircraft are acquired by means of an All-Call interrogation, or by means of ground-to-ground handover. After acquisition, DABS-equipped aircraft are interrogated with their unique address call. For both ATCRBS and DABS-equipped aircraft, azimuth is determined by a monopulse technique. System coverage for both ATCRBS and DABS targets is intended to identical to that described in paragraph 1.3.2 of reference A.

1.4.2 Data Link

The DABS sensor will provide a two-way digital data link for all DABS-equipped aircraft. Messages originating on the ground are sent to suitably equipped aircraft and appropriate acknowledgment received is relayed to the sender. The DABS sensor also manages the data link so that when an aircraft wishes to initiate an air-to-ground message, that message is read out with minimum delay.

1.4.3 Link Reliability

High link reliability is achieved by design features intrinsic to the DABS system. Reinterrogation reduces link failure due to interference. Signal formats, differential phase shift keying on the uplink and pulse position modulation with error correction capability on the downlink, provide high link reliability in a pulse interference environment. Discrete addressing eliminates synchronous interference for DABS-equipped aircraft.

1.5 Glossary of Acronymns

ATARS: Automatic Traffic Advisory and Resolution Service

ATCRBS: Air Traffic Control Radar Beacon System

BCAS: Beacon Collision Avoidance System

CIR: Conflict Indicator Register

DABS: Discrete Address Beacon System

1.6 References

Reference A: "U.S. National Standard for the IFF Mark X (SIF)/Air Traffic Control Radar Beacon System Characteristics", FAA, 1010.51A, 8 March 1971.

2. Signals in Space

Note.—This section describes all rf characteristics of the DABS signals.

2.1 DABS Frequencies

The carrier frequency of DABS interrogations (uplink) is 1030 ±0.01 MHz.

The carrier frequency of DABS replies (downlink) is 1090 ±3 MHz.

Note.—The carrier frequencies are identical to those used in the ATCRBS system and specified in ref. A. The frequency tolerance for the DABS interrogation is tighter than for ATCRBS in order to accommodate phase shift modulation; while the reply frequency tolerance remains at ±3 MHz to allow continued use of ATCRBS airborne hardware.

2.1.1 Polarization

Vertical polarization is used in DABS transmissions.

2.2 DABS Modulation

The modulation of DABS carrier frequencies consists of pulses some of which have internal phase modulation.

2.2.1.1 Pulse Shapes

Pulse shapes are defined as described in ref. A, section 2.

2.2.1 Pulse Shapes, Interrogations

The specifications for pulse shapes used in DABS interrogations are summarized in the following table. All values are in microseconds.

Pulse designator	Pulse duration	Duration tolerance	Rise time Min.	Rise time Max.	Decay time Min.	Decay time Max.
P_1, P_2, P_3, P_5	0.8	±0.1	0.05	0.1	0.05	0.2
P_1 (short)	0.8	±0.1	0.05	0.1	0.05	0.2
P_6 (long)	1.6	±0.1	0.05	0.1	0.05	0.2
P_6 (short)	16.25	±0.25	0.05	0.1	0.05	0.2
P_6 (long)	30.25	±0.25	0.05	0.1	0.05	0.2

Note.—The 0.8-microsecond pulses used in DABS interrogations are identical in shape to those used in ATCRBS and described in ref. A, 2.4.5.

2.2.1.2 Pulse Shapes, Replies

The specifications for pulse shapes used in DABS replies are summarized in the following table. All values are in microseconds.

Pulse duration	Tolerance	Rise time Min.	Rise time Max.	Decay time Min.	Decay time Max.
0.45	±0.1	0.05	0.1	0.05	0.2
0.5	±0.05	0.05	0.1	0.05	0.2
1.0	±0.05	0.05	0.1	0.05	0.2

Note.—The 0.45-microsecond pulses are used for replies to ATCRBS Interrogations and are listed here only for convenience. The (identical) specifications of ref. A, 2.6 apply.

2.2.2 Phase Modulation

The short (16.25-microsecond) and long (30.25-microsecond) P_6 pulses of 2.2.1.1 have internal modulation consisting of 180-degree phase reversals of the carrier at designated times.

2.2.2.1 Phase Reversal Duration

The duration of the phase reversal is less than 0.08 microsecond as measured between the 10 degree and 170 degree points of the phase transition. The interval between the 80 percent points of the amplitude transient associated with the phase reversal is less than 0.08 microsecond.

2.2.2.2 Phase Relationship

The tolerance on the 0 or 180 degree phase relationship between successive chips within the P_6 pulse (including the sync phase reversal) is ±5 degrees.

Note.—A "chip" is the shortest carrier interval between successive phase reversals.

2.2.2.3 Sync Phase Reversal

The first reversal in the P_6 pulse is the Sync Phase Reversal and occurs nominally 1.25 microseconds after the leading edge.

Note.—The sync phase reversal is the timing benchmark for succeeding transponder operations.

2.2.2.4 Data Phase Reversals

The center of each following data phase reversal can occur only at a time $(N \times 0.25) \pm 0.02$ microseconds $(N>2)$ after the Sync Phase Reversal.

Note.—56 or 112 data phase reversals can occur in the 16.25- amd 30.25-microsecond P_6 pulses respectively. This results in a 4 Mb/sec data rate within the pulses.

2.3 Pulse Sequences

Specific sequences of the pulses or phase reversals described in 2.2 constitute DABS interrogations and replies.

2.3.1 ATCRBS/DABS All-Call and ATCRBS-Only All-Call Interrogations

These interrogations consist of three pulses: P_1, P_3, and P_4. One or two control pulses (P_2 alone, or P_1 and P_2) are transmitted using a separate antenna pattern to suppress responses from aircraft in the sidelobes of the interrogator antenna. See Fig. 2.3–1.

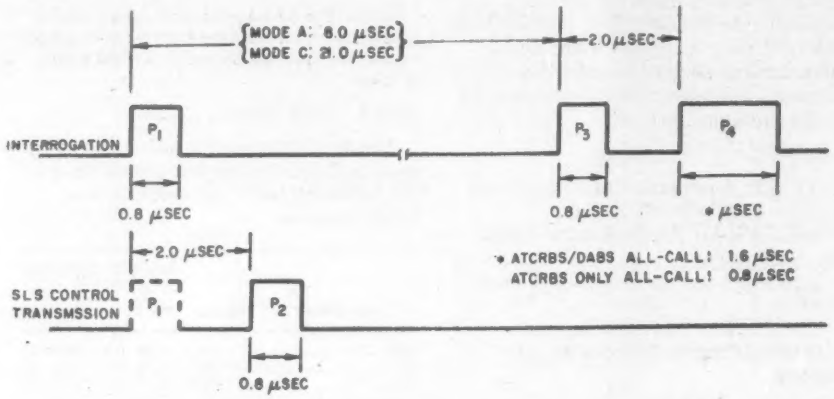


Fig. 2.3-1. ATCRBS/DABS and ATCRBS-Only All-Call Interrogation Pulse Sequence.

2.3.1.1 Pulse Definitions and Spacing

P_1, P_3, and P_3 have shapes and spacings as defined in ref. A, 2.4. P_4 is either a 0.8-microsecond pulse or a 1.6-microsecond pulse (2.2.1.1) and occurs 2 ± 0.05 microseconds after P_3, measured from leading edge to leading edge.

2.3.1.2 Pulse Levels

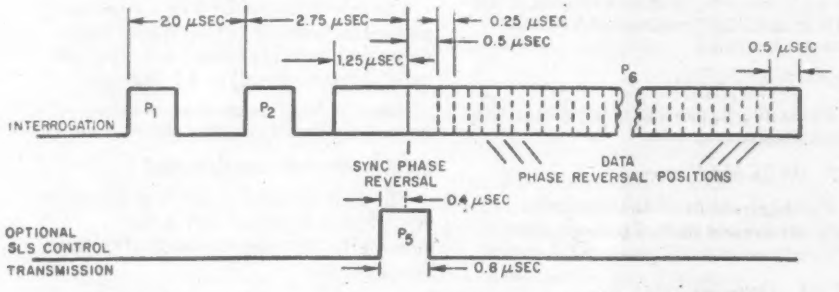
Relative levels between pulses P_1, P_2, and P_3 are in accordance with ref. A, 2.5.

The radiated amplitude of P_4 is within 1 dB of the radiated amplitude of P_3.

Note.—P_1, P_2, and P_3 are 0.8-microsecond pulses. Spacings: $P_1 - P_2 = 2 \pm 0.15$ microseconds; $P_1 - P_3 = 8$ or 21 ± 0.2 microseconds. Levels: $P_1 - P_2$ = see ref. A, 2.5.2; $P_1 - P_3$ = within 1 dB. ATCRBS/DABS All-Call and ATCRBS-Only All-Call interrogations correspond in their pulse sequence to the ATCRBS interrogations of ref. A, 2.4. The additional P_4 pulse is not seen by ATCRBS transponders which reply as usual. DABS transponders recognize the long P_4 of the ATCRBS/DABS All-Call interrogation and reply with a DABS format. DABS transponders recognize the short P_4 of the ATCRBS-Only All-Call interrogation and do not accept such interrogations.

2.3.2 DABS Interrogations

The DABS interrogation sequence consists of three pulses: P_1, P_2, and P_6. A control pulse, P_5, is transmitted using a separate antenna pattern to suppress acceptance of interrogation by aircraft in the sidelobes of the interrogator antenna. See Fig. 2.3–2.



Note: The P6 pulse includes a 0.5 μsec segment at the end to ensure that the trailing edge of the pulse does not interfere with the last bit in the data block.

Fig. 2.3-2. DABS Interrogation Pulse Sequence.

2.3.2.1 Pulse Definition

P_1, P_2, and P_5 are 0.8-microsecond pulses. P_6 is either a 16.25-microsecond or a 30.25-microsecond pulse (2.2.1.1) containing phase reversals.

2.3.2.2 Pulse Spacings

Between leading edges the spacing from P_1, P_2 is 2 ± 0.05 microseconds. The spacing from the leading edge of P_2 to the sync phase reversal of P_6 is 2.75 ± 0.05 microseconds. The leading edge of P_6 occurs 1.25 ± 0.05 microseconds before the sync phase reversal. P_5, if transmitted, is centered over the sync phase reversal.

2.3.2.3 Pulse Levels

The radiated amplitudes of P_2 and the initial first microsecond of P_6 are greater than the radiated amplitude of P_1 minus 0.25 dB. The envelope amplitude variation of P_6 is less than 1 dB and the amplitude variation between successive phase modulation chips in P_6 is less than 0.25 dB. P_5 is radiated with the same antenna pattern and amplitude as P_2 of (2.3.1.2).

Note.—The phase reversals within P_6 contain the information conveyed by the DABS interrogation. P_6 is preceded by the P_1-P_2 pair which, when received, suppresses replies from ATCRBS transponders to avoid synchronous garble due to random triggering of ATCRBS transponders by the DABS interrogation. The action of P_5 is automatic: Its presence, if of sufficient amplitude at the receiving location, masks the sync phase reversal of P_6 so that decoding of P_6 cannot be accomplished.

2.3.3 ATCRBS Replies

DABS transponders reply to ATCRBS Mode A or Mode C interrogations as described in ref. A, 2.6, unless inhibited by reply rate limiting.

2.3.4 DABS Replies

The DABS reply waveform is shown in Fig. 2.3–3.

Note.—DABS replies consist of a four-pulse preamble followed by a series of pulses which carry either 56 or 112 information bits by means of pulse position modulation (PPM).

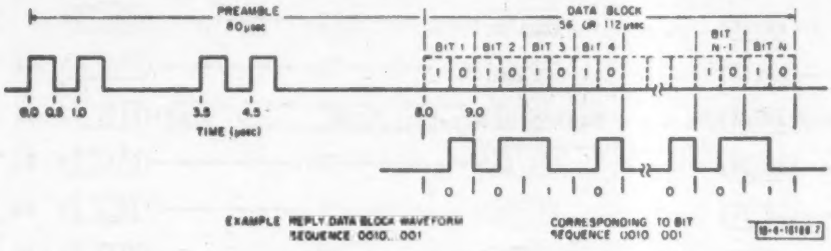


Fig. 2.3–3. DABS Reply Waveform.

2.3.4.1 Pulse Definition

All pulses in DABS replies are either 0.5- or 1-microsecond pulses according to 2.2.1.2.

2.3.4.2 Pulse Spacings

All reply pulses start at a defined multiple of 0.5 microseconds from the first transmitted pulse, measured between leading edges. The pulse position tolerance in all cases is ±0.05 microseconds.

2.3.4.2.1 Reply Preamble

The preamble consists of four 0.5-microsecond pulses. The second, third, and fourth pulses are spaced 1, 3.5, and 4.5 microseconds respectively from the first transmitted pulse.

2.3.4.2.2 Reply Data Pulses

The block of reply data pulses begins 8 microseconds after the first transmitted pulse. Either 56 or 112 one-microsecond intervals are assigned to each transmission. A 0.5-microsecond pulse is transmitted either in the first or in the second half of each interval. If a pulse transmitted in the second half of one interval is followed by another pulse transmitted in the first half of the next interval, the two pulses merge and a 1-microsecond pulse (2.2.1.2) is transmitted.

2.3.4.3 Pulse Levels

The pulse amplitude variation between one pulse and any other pulse in a DABS reply does not exceed 2 dB.

2.4 DABS Spectra

Note.—The emission spectrum of a DABS transmission is concentrated around the carrier frequency.

2.4.1 Interrogation RF Spectrum.

The spectrum of a valid of DABS interrogation does not exceed the following bound.

Frequency difference (from carrier freq., MHz)	Maximum relative response (dB down from peak)
4	5
6	11
8	15
10	19
20	31
30	38
40	43
50	47
60	50

Note. The "worst case" spectrum is generated by a P_6 pulse which contains all possible phase reversals.

2.4.2 Reply RF Spectrum

The spectrum of a valid DABS reply does not exceed the following bound.

Frequency difference (MHz from 1090 MHz)	Maximum relative response (dB down from peak)
4.3	3.0
10.0	20.0
26.0	40.0
81.0	60.0

Note.—The first column in this table corresponds to the center frequency tolerance allowed for a transponder.

3. Signal Content

Note.—This section describes the location and coding of the information contained in DABS transmissions.

3.1 Data Blocks

The interrogation and reply data blocks can contain either 56 or 112 bits.

3.1.1 Interrogation Data Blocks

The interrogation data block consists of the sequence of carrier phase reversals within P6; see 2.2.2. A 180-degree phase shift of the carrier preceding a data chip characterizes that chip as a binary "one". No preceding phase shift denotes a binary "zero".

3.1.2. Reply Data Blocks

The reply data block is formed by binary pulse position modulation encoding of the reply data as described in 2.3.4.2.2. A pulse transmitted in the first half of the interval represents a binary "one" while a pulse transmitted in the second half represents a binary "zero".

3.2 Format Structure, Interrogation and Reply

The available coding space is occupied by either 56 or 112 bits of which 24 bits are used as the address of the aircraft while the rest are used for information transfer. A summary of interrogation and reply formats is presented in Figures 3.2–1 and 3.2–2.

3.2.1 Bit Numbering and Sequence

The bits are numbered in order of their transmission, beginning with bit 1. If numerical values are encoded by groups of bits (fields) then the bit transmitted first is the most significant bit (MSB).

Note.—This rule need not apply to codes used in DABS data link messages.

3.2.2 Fields

Information is coded in fields which consist of at least one or more bits. In this document the decimal equivalent of the binary code formed by the bit sequence within a field is used as the designator of the field function or command.

Note.—As an example, the 6-bit UF field is used to designate the uplink format type. The surveillance interrogation with identity is designated by a UF code of 00101. Since $00101_2=5_{10}$, this format is designated as UF 5.

Format No. UF		
0	(0 0000)(AQ:1)(BI:26)(AP:24).	Short Special Surveillance
1	(0 0001)----------27----------(AP:24)	
2	(0 0010)(EP:8)-------19----------(AP:24).	Short Synchr. Surveillance
3	(0 0011)----------27----------(AP:24)	
4	(0 0100)(PC:3)(RR:5)(DI:3)(SD:16)(AP:24).	Surveillance, Altitude
5	(0 0101)(PC:3)(RR:5)(DI:3)(SD:16)(AP:24).	Surveillance, Identity
6	(0 0110)----------27----------(AP:24).	Ground-Air Coordination
7	(0 0111)----------27----------(AP:24)	
8	(0 1000)----------27----------(AP:24)	
9	(0 1001)----------27----------(AP:24)	
10	(0 1010)----------27----------(AP:24)	
11	(0 1011)(PR:4)(II:4)(--19 one's--)(AP:24).	DABS-Only All-Call
12	(0 1100)----------27----------(AP:24)	
13	(0 1101)----------27----------(AP:24)	
14	(0 1110)----------27----------(AP:24)	
15	(0 1111)----------27----------(AP:24)	
16	(1 0000)(AQ:1)(BI:26)(MU:56)(AP:24).	.Long Special Surveillance
17	(1 0001)----------83----------(AP:24)	
18	(1 0010)(EP:8)-------19----------(MS:56)(AP:24).	.Long Synchr. Surveillance
19	(1 0011)----------83----------(AP:24)	
20	(1 0100)(PC:3)(RR:5)(DI:3)(SD:16)(MA:56)(AP:24).	.Comm-A, Altitude
21	(1 0101)(PC:3)(RR:5)(DI:3)(SD:16)(MA:56)(AP:24).	.Comm-A, Identity
22	(1 0110)----------83----------(AP:24).	.Ground-Air Coordination
23	(1 0111)----------83----------(AP:24)	
24	(11)(RC:2)(NC:4)(MC:80)(AP:24).	.Comm-C (ELM)

Notes: (1) (XX:M) denotes a field designated "XX" which is assigned M bits,
(2) ---N--- denotes free coding space with N available bits,
(3) UF (Uplink Format) codes 24 through 31 are reserved for Comm-C transmissions. The leading bits of these codes are always "11"; the remaining bits vary with the content of the RC and NC fields.

Fig. 3.2-1. Summary of DABS Interrogation or Uplink Formats.

Format No.	DF						
0	(0 0000)	(AQ:1)	(BR:13)	(AC:13)	(AP:24)	. . . . .	Short Special Surveillance
1	(0 0001)	----------27----------			(AP:24)		
2	(0 0010)	(EP:8)	--------6-----	(AC:13)	(AP:24)	. . . . .	Short Synchr. Surveillance
3	(0 0011)	----------27----------			(AP:24)		
4	(0 0100)	(FS:3)	(DR:5) (UM:6)	(AC:13)	(AP:24)	. . . . .	Surveillance, Altitude
5	(0 0101)	(FS:3)	(DR:5) (UM:6)	(ID:13)	(AP:24)	. . . . .	Surveillance, Identity
6	(0 0110)	----------27----------			(AP:24)	. . . . .	Not Used
7	(0 0111)	----------27----------			(AP:24)		
8	(0 1000)	----------27----------			(AP:24)		
9	(0 1001)	----------27----------			(AP:24)		
10	(0 1010)	----------27----------			(AP:24)		
11	(0 1011)	(CA:3)	(AA:24)		(PI:24)	. . . . .	All-Call Reply
12	(0 1100)	----------27----------			(AP:24)		
13	(0 1101)	----------27----------			(AP:24)		
14	(0 1110)	----------27----------			(AP:24)		
15	(0 1111)	----------27----------			(AP:24)		
16	(1 0000)	(AQ:1)	(BR:13)	(AC:13) (SC:56)	(AP:24)	. .	Long Special Surveillance
17	(1 0001)	----------83----------			(AP:24)		
18	(1 0010)	(EP:8)	--------6-----	(AC:13) (MT:56)	(AP:24)	. .	Long Synchr. Surveillance
19	(1 0011)	----------83----------			(AP:24)		
20	(1 0100)	(FS:3)	(DR:5) (UM:6)	(AC:13) (MB:56)	(AP:24)	. .	Comm-B, Altitude
21	(1 0101)	(FS:3)	(DR:5) (UM:6)	(ID:13) (MB:56)	(AP:24)	. .	Comm-B, Identity
22	(1 0110)	----------83----------			(AP:24)	. .	Not Used
23	(1 0111)	----------83----------			(AP:24)		
24	(11)	--1--	(KE:1) (ND:4)	(MD:80)	(AP:24)	. .	Comm-D (ELM)

Notes: (1) (XX:N) denotes a field designated "XX" which is assigned N bits,
(2) ---N--- denotes free coding space with N available bits,
(3) DF (Downlink Format) codes 24 through 31 are reserved for Comm-D transmissions. The leading bits of these codes are always "11"; the remaining bits vary with the content of the KE and ND fields.

Fig. 3.2-2. Summary of DABS Reply or Downlink Formats.

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3.2.2.1 Essential Fields

Each DABS transmission contains two essential fields: one decribing the format and the other providing the transponder's address. The format descriptor is a 5 bit field at the beginning of the transmission and the address field always occurs at the end of the transmission. The formats are described by the UF (Uplink Format) or DF (Downlink Format) fields. The 24 bit field which carriers parity information contains either the address or the interrogator identity overlaid on parity according to 4.1. The designators are AP (Address/Parity) or PI (Parity/Identity).

3.2.2.2. Mission Fields

The remaining coding space is used to transmit the mission fields. For specific missions, a specific field complement is prescribed. Mission fields have 2-letter designators.

3.2.2.3 Subfields

Subfields may appear within established fields. Subfields are labelled with three-letter designators.

3.3 Field Descriptions

The fields are decribed in alphabetical order in the following paragraphs. An index is provided in Table 3.3–1.

3.3.1 AA Address, Announced

Downlink, 24 bits, 9 through 32. Appears in Downlink Format DF-11, the All-Call reply. Contains aircraft address in the clear.

3.3.2 AC Altitude Code

Downlink, 13 bits, 20 through 32. Appears in downlink formats which report aircraft altitude. Coded according to pattern of ref. A, 2.6.2 and ref. A, Attachment 1. Starting with bit 20, the sequence is C1, A1, C2, A2, C4, A4, M, B1, D1, B2, D2, B4, D4. Metric altitude is contained in this field if the M bit (bit 26) is set to "one".

Note.—Metric altitude codes are not included in this Standard but may be defined in a future Standard.

3.3.3 AP Address/Parity

Uplink and downlink, 24 bits, 33 through 56 or 89 through 112. Parity is overlaid on the address according to 4.1.2.

Table 3.3-1. FIELD INDEX

Field	Sub Field	Bits No.	Bits Position	Formats Up	Formats Down	Reference Paragraph(s) Content	Reference Paragraph(s) Protocol
AA		24	9-32		X	3.3.1	
AC		13	20-32		X	3.3.2	
AP		24	33-56 89-112	X	X	3.3.3	4.1.3, 4.2.1.1, 4.2.1.2
AQ		1	6	X	X	3.3.4	4.18.1
BI		26	7-32	X		3.3.5.1	
BR		13	7-19		X	3.3.5.2	
	MXS	3	17-19		X	3.3.5.2.1	
CA		3	6-8		X	3.3.6	4.6.1
DF		5	1-5		X	3.3.7	
DI		3	14-16	X		3.3.8	
DR		5	9-13		X	3.3.9	4.4.1, 4.11.2
EP		8	6-13	X	X	3.3.10	4.16
FS		3	6-8		X	3.3.11	4.5
ID		13	20-32		X	3.3.12	
II		4	10-13	X		3.3.13	4.12.1.1&2
KE		1	4		X	3.3.14	4.11.1.3.2
MA		56	33-88	X		3.3.15	
	ADS	8	33-40	X		3.3.15.1	
MB		56	33-88		X	3.3.16	4.10, 4.19
	BDS	8	33-40		X	3.3.16.1	4.10.1
	ECS	16	71-86		X	4.6.2.1	
	EDS	2	87,88		X	4.6.2.1	
	FIS	42	47-88		X	4.13	
MC		80	9-88	X		3.3.17	
	SRS	16	9-24	X		4.11.2.2.1	
MD		80	9-88		X	3.3.18	
	DSS	8	9-16		X	4.11.2.2.2	
	TAS	16	17-32		X	4.11.1.3.3	4.11.1.3.3
MS		56	33-88	X		3.3.19	
MT		56	33-88		X	3.3.20	
MU		56	33-88	X		3.3.21	
NC		4	5-8	X		3.3.22	4.11.1
ND		4	5-8		X	3.3.23	4.11.2.2
PC		3	6-8	X		3.3.25	4.3, 4.9, 4.10
PI		24	33-56		X	3.3.26	4.1.3
PR		4	6-9	X		3.3.27	4.3.1
RC		2	3,4	X		3.3.28	4.11.1, 4.11.2.2
RR		5	9-13	X		3.3.29	4.2.2.1
SC		56	33-88		X	3.3.30	
SD		16	17-32	X		3.3.31	4.12.1.1, 4.15, 4.19
	IIS	4	17-20	X		4.12.1.1	
	LOS	1	26	X		4.12.1.1	
	MBS	2	21,22	X		4.12.1.1	
	MES	3	23-25	X		4.12.1.1	
	RRS	4	17-20	X		4.10.1.1.1	4.10.1.1
	RSS	2	27,28	X		4.12.1.1	
UF		5	1-5	X		3.3.32,	
UM		6	14-19		X	3.3.33	4.7
	IDS	2	18,19		X	4.12.1.2	
	IIS	4	14-17		X	4.12.1.2	

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3.3.4 AQ Acquisition, Special

Uplink and downlink, 1 bit, 6. Appears in special surveillance formats UF=DF=0, and UF=DF=16. The code appearing in this field, when received in the uplink is repeated in the downlink.

Note.—This field identifies the BCAS acquisition reply.

3.3.5 BCAS Data

3.3.5.1 BI BCAS Interrogation Data

Uplink, 26 bits, 7 through 32. Appears in uplink special surveillance formats UF=0, 16. Contains BCAS data.

Note.—Message content and codes are not included in this Standard.

3.3.5.2 BR BCAS Reply Data

Downlink, 13 bits, 7 through 19. Appears in downlink special surveillance formats DF=0, 16.

Note.—Message content and codes other than MXS (see 3.3.5.2.1) are not included in this Standard.

3.3.5.2.1 Subfields in BR: MXS Maximum Airspeed Subfield

Aircraft report their maximum airspeed by inserting one of the codes shown below into the MXS subfield. MXS is a three bit field, located in bits 17 through 19.

Coding:

0 = No data available
1 = airspeed is up to 75 knots
2 = airspeed is between 75 and 150 knots
3 = airspeed is between 150 and 300 knots
4 = airspeed is between 300 and 600 knots
5 = airspeed is between 600 and 1200 knots
6 = airspeed is more than 1200 knots
7 = aircraft is on the ground

Note.—This report is used by BCAS to aid in tracking DABS aircraft. For implementation see 5.5.1.1. The maximum airspeed flown in normal operation is used.

3.3.6 CA Capability

Downlink, 3 bits, 6 through 8. Appears in All-Call reply format, DF=11.

Coding:

0 = Minimum capability
1 = Additional capability (4.6.2)
2 = Extended capability (4.6.3)
3 = Additional and extended capability
4–7 Not assigned

3.3.7 DF Downlink Format

Downlink, 5 bits, 1 through 5. Appears in all downlink transmissions. This field is the downlink descriptor. Coding according to Fig. 3.2–2.

3.3.8 DI Designator Identification

Uplink, 3 bits, 14 through 16:

Appears in uplink surveillance and Comm-A formats, UF=4, 5, 20, 21. Contains identification of coding in the SD field.

Coding:

0 = Not assigned
1 = SD contains multisite information (4.12)
2 = SD contains ATARS-CIR information (4.18)
3—6 Not assigned
7 = SD contains extended reply request (4.10.1.1)

Note 1.—The CIR (Conflict Indicator Register) is used to coordinate the activities of ATARS and BCAS.

Note 2.—ATARS and CIR message content and codes are not included in this Standard.

3.3.9 DR Downlink Request

Downlink, 5 bits, 9 through 13. Appears in surveillance and Comm-B replies, DF=4, 5, 20, 21.

Coding:

0 = No action
1 = B bit set
2 = CIR bit set
3 = CIR and B bits set
4–15 Not assigned
16–31 See Comm-D protocol, 4.11.2.1

3.3.10 EP Epoch

Uplink and downlink, 8 bits, 6 through 13. Appears in uplink and downlink synchronous surveillance formats, UF=DF=2, 18.

Note.—The message content and codes are not included in this Standard. The content of this field in the uplink is repeated in the downlink (4.15).

3.3.11 FS Flight Status

Downlink, 3 bits, 6 through 8. Appears in downlink surveillance and Comm-B formats, DF=4, 5, 20, 21. Contains flight status.

Coding:

0 = Normal, airborne
1 = BCAS Interrogating
2 = ALERT
3 = Not assigned
4 = SPI
5 = Not assigned
6 = ALERT, SPI
7 = On the ground

Note.—The meaning of these codes is explained in 4.5.

3.3.12 ID Identification, (4096 code)

Downlink, 13 bits, 20 through 32. Appears in downlink formats which report aircraft identification. Coded to pattern corresponding to ref. A, 2.6.

3.3.13 II Interrogator Identification

Uplink, 4 bits, 10 through 13. Appears in DABS-only All-Call, UF=11. identifies interrogator and is used in multisite lockout protocol 4.12.6.

Note.—The same information also may appear in the IIS subfields of 4.12.1.1 and 4.12.1.2.

3.3.14 KE Control, ELM

Downlink, 1 bit, bit 4. Appears in Comm-D replies. Defines content of ND, MD fields. Coding according to 4.11.1.3.2.

3.3.15 MA Message, Comm-A

Uplink, 56 bits, 33 through 88. Appears in Comm-A interrogations, UF=20,21. Used to transmit messages to the aircraft. Contains 8-bit ADS (Comm-A Definition) field.

Note.—Message content and codes are not included in this Standard.

3.3.15.1 Subfields in MA: ADS, A-Definition Subfield

Located in bits 33 through 40, this 8-bit subfield denotes the definition of the data contained in MA. For convenience in coding, ADS is expressed in two groups of 4 bits each, ADS1 and ADS2.

3.3.16 MB Message, Comm-B

Downlink, 56 bits 33 through 88. Appears in Comm-B replies, DF=20,21. Used to transmit messages to the gound. Contains 8-bit BDS (Comm-B Definition) field.

Note.—Message content and codes are not included in this Standard; exceptions are described in 3.3.16.1 and 4.6.3.

3.3.16.1 Subfields in MB: BDS, B-Definition Subfield

Located in bits 33 through 40, this 8-bit subfield in MB indicates the source of the data in the remainder of MB. For convenience in coding, BDS is expressed in two groups of 4 bits each, BDS1 and BDS2.

3.3.17 MC Message, Comm-C

Uplink, 80 bits, 9 through 88. Appears in Comm-C interrogations. Contains Comm-C data.

Note.—Message content and codes are not included in this Standard.

3.3.18 MD Message, Comm-D

Downlink, 80 bits, 9 through 88. Appears in Comm-D replies, DF's 24 through 31. Contains Comm-D data.

Note.—Message content and codes are not included in this Standard.

3.3.19 MD Message, Synchronized, Interrogation

Uplink, 56 bits, 33 through 88. Appears in long synchronized surveillance interrogation, UF=18.

Note.—Message content and codes are not included in this Standard.

3.3.20 MD Message, Synchronized, Reply

Downlink, 56 bits, 33 through 88. Appears in long synchronized surveillance reply, DF=18.

Note.—Message content and codes are not included in this Standard.

3.3.21 MD Message, Interrogation

Uplink, 56 bits, 33 through 88. Appears in long special surveillance interrogations, UF=16. Contains BCAS data.

Note.—Message content and codes are not included in this Standard.

3.3.22 NC Number of C-Segment

Uplink, 4 bits, 33 through 8. Appears in Comm-C interrogations. Designates segment number of this transmission per 4.11.1.1.

3.3.23 ND Number of D-Segment

Downlink, 4 bits, 5 through 8. Appears in Comm-D replies. Designates segment number of this transmission per 4.11.2.2.

3.3.24 PC Protocol

Uplink, 3 bits, 6,7,8. Appears in surveillance and Comm-A interrogations, UF=4,5,20,21. Contains operating commands to the transponder. Coding:

0=no action
1=Standard All-Call lockout (4.3.1)
2=Squitter lockout (4.3.2)
3=Standard All-Call lockout and squitter lockout
4=cancel B (4.10.2)
5=cancel C (4.11.1.3.4)
6=cancel D (4.11.2.3)
7=not assigned

3.3.25 PI Parity/Interrogator Identifier

Downlink, 24 bits, 33 through 56. Appears in reply to DABS-only All-Call, DF=11. Parity is overlaid on interrogator identifier according to 4.1.2.

3.3.26 PR Probability of Reply

Uplink, 4 bits, 6 through 9. Appears in DABS-only All-Call interrogation, UF=11. Contains designated reply probability and lockout override command. Coding:

0=reply with probability=1
1=reply with probability=½
2=reply with probability=¼
3=reply with probability=⅛
4=reply with probability=1/16
5,6,7 not assigned
8=disregard lockout, reply with probability=1
9=disregard lockout, reply with probability=½
10=disregard lockout, reply with probability=¼
11=disregard lockout, reply with probability=⅛
12=disregard lockout, reply with probability=1/16
13,14,15 not assigned

3.3.27 RC Reply Control

Uplink, 2 bits, 3 and 4. Appears in Comm-C interrogations. Designates segment significance and reply decision per 4.11.1 and 4.11.2.2.

3.3.28 RR Reply Request

Uplink, 5 bits, 9 through 13. Appears in surveillance and Comm-A interrogations, UF=4,5,20,21. Contains length and content of requested reply and content of the UM field.

Coding:

RR code	Reply length	MB control	UM content
0	Short		Voluntary message, if any (3.3.32.2)
1	Short		Additional capability (4.6.2)
2	Short		See note 1
3 to 15	Short		Not assigned
16	Long	Air initiated comm B (4.10).	See note 1
17	Long	Extended capability (4.6.3).	See note 1
18	Long	Flight ID (4.13).	See note 1
19	Long	ATARS/CIR (4.18).	See note 1
20	Long	Data link (see note 3).	See note 1
21	Long	Not assigned.	See note 1
22	Long	BCAS (see note 3).	See note 1
23 to 31	Long	Not assigned.	See note 1

Note 1.—The contents of UM may be specified by coding in the SD field of the interrogation.

Note 2.—The last four bits of the 5-bit RR Code, if transformed into their decimal equivalent, designate the number (BDS1) of the requested source if the first bit of the RR code is a one.

Note 3.—Data Link and BCAS message codes are not included in this Standard.

3.3.29 SC Special Communication

Downlink, 56 bits, 33 through 88. Appears in long special reply DF=16. Contains BCAS data.

Note.—Message content and codes are not included in this Standard.

3.3.30 SD Special Designator

Uplink, 16 bits, 17 through 32. Appears in surveillance and Comm-A interrogations, UF=4,5,20,21. Contains control codes directed to the transponder. Coding depends on the content of the DI field.

3.3.30.1 Subfields in SD

Note.—Subfields within SD are described in 4.10.1.1.1, and 4.12.1.1.

3.3.31 UF Uplink Format

Uplink, 5 bits, 1 through 5. Appears in all uplink transmissions. This field is the uplink descriptor. Coding according to Fig. 3.2–1.

Note.—This field uniquely identifies the structure and content of all DABS interrogations.

3.3.32 UM Utility Message

Downlink, 6 bits, 14 through 19. Appears in surveillance and Comm-B replies: DF=4,5,20,21. Contains requested or volunteered data (see 4.7).

Note.—The UM field is provided in order to accomplish simple message interchanges between the aircraft and the ground.

3.3.32.1 Subfields in UM

Note.—Subfields within UM are described in 4.6.2 and in 4.12.1.2.

3.3.32.2 Voluntary Information

Voluntary information in the UM field is encoded according to a predetermined list of 64 different messages. The six bits in the UM field can form 64 different codes, numbered 0 through 63. Known messages are:

0 No message.
1 Change in capability status.
2 through 63 Not assigned.

4. Protocol

Note.—This section describes the interactions between the sensor (interrogator) and the transponder required for the proper function of the DABS surveillance and data link tasks. Data interchanged on the DABS link may have their own sub-protocols: these are not part of this Standard.

4.1 Error Protection

4.1.1 Technique

Parity check coding is used within DABS interrogations and replies to provide protection against the occurrence of errors.

4.1.1.1 Parity Check Sequence

A sequence of 24 parity check bits is generated by a code described in 4.1.1.2 and is incorporated into the field formed by the last 24 bits of all DABS transmissions. The 24 parity check bits are combined with either the address or the interrogator identification as described in 4.1.2. The resulting combination then forms either the AP (Address/Parity) or the PI (Parity/Identification) fields.

4.1.1.2 Parity Check Sequence Generation

The sequence of 24 parity bits ($p_1, p_2, \ldots p_{24}$) is generated from the sequence of information bits ($m_1, m_2, \ldots m_k$) where k is 32 or 88 for short or long transmissions respectively. This is done by means of a code which is generated by the polynomial:

$$G(x) = \sum_{i=0}^{24} g_i x^i$$

where $g_i = \begin{cases} 1 \text{ for } i = 0, 3, 10, \text{ and } 12 \text{ through } 24 \\ 0 \text{ otherwise} \end{cases}$

When by the application of binary polynomial algebra the above G)x) is divided into the information sequence expressed as:

$M(x) = m_0 + m_1 x + m_2 x^2 + \ldots + m_{k-1} x^{k-1}$

the result is a quotient and a remainder R(x) of degree < 24. The bit sequence formed by this remainder represents the parity check sequence. Parity p_i, for any i from 1 to 24, is the coefficient of x^{24-i} in R(x).

4.1.2 AP or PI Field Generation

The address is formed by a sequence of 24 bits, $(a_1, a_2 \ldots a_{24})$ where a_1 is the bit transmitted first in the AA field of an All-Call reply (3.3.1). This address sequence is used in the downlink Address/Parity field generation, while a modified form of this sequence $(b_1, b_2 \ldots b_{24})$ is required for uplink Address/Parity field generation.

The interrogator identifier is formed by a sequence of 24 bits, $(a_1, a_2 \ldots a_{24})$ where the first 20 bits have zero value and the last four bits are a replica of the II field 3.3.13.

Bit b_i is the coefficient of x^{i-1} in the polynomial H(x)A(x), where

$A(x) = a_1 + a_2 x + a_3 x^2 + \ldots + a_{24} x^{24}$

and

$$H(x) = \sum_{i=0}^{24} g_i x^{24-i}$$

The sequence of bits transmitted in the Address/Parity field is:

$t_{k+1}, t_{k+2} \quad t_{k+24}.$

Note.—The bits are numbered in order of transmission, starting with "1".

4.1.2.1 Uplink Field

In uplink transmissions:

$t_{k+i} = b_i \oplus P_i$

where " $\oplus$ " prescribes modulo-2 addition.

4.1.2.2 Downlink Field

In downlink transmissions:

$t_{k+i} = a_i \oplus P_i$

where " $\oplus$ " prescribes modulo-2 addition.

4.2 Reply Protocol

Note.—The DABS system is based on the principle of directed interrogations. Interaction between the interrogator and the transponder occurs only if the transponder is correctly addressed.

4.2.1 Interrogation Acceptance

DABS interrogations are accepted only if:

1. The address of the recipient is as defined in 4.2.1.1 and 4.2.1.2.
2. Parity (4.1) is established.
3. No lockout condition (4.3.1) or 4.12.6 applies.
4. The sync phase reversal within P6 (2.2.2.3) is detected at its specified location.

4.2.1.1 Discrete Address

Each transponder is assigned a unique address. If the address so assigned is identical to the address extracted from the received interrogation according to 4.1.2 and 4.1.2.1, the interrogation is accepted and the content is evaluated and acted upon according to protocols described elsewhere in this Standard.

4.2.1.2 All-Call Address

If the address extracted from the received interrogation consists of 24 binary "ones", the received interrogation is accepted. The response of the transponder to such an interrogation depends on the content of the transmission. If UF=11, the transmission is a DABS-only All-Call (4.2.1.3). If UF=11, the transmission is designated a "broadcast" (4.14).

4.2.1.3 DABS-only All-Call

On receipt of the DABS-only All-Call, UF 11, the decoding process of 4.1.2 and 4.1.2.1 results in an address consisting of 24 binary ones. This is the universal All-Call address and this interrogation is accepted unless the lockout protocol of 4.3.1 or 4.12.6 is in effect.

4.2.1.4 ATCRBS/DABS All-Call

On receipt of an ATCRBS/DABS All-Call interrogation (2.3.1) it is implied that an address consisting of 24 binary ones has been received. The interrogation is accepted unless either the lockout protocol of 4.3.1 or suppression (4.2.2.3.3) is in effect.

Receipt of an ATCRBS/DABS All-Call interrogation also has the same effect as reception of the unlink format (UF) 11 with a unity probability-of-reply command.

4.2.2 Interrogation—Reply Coordination

The reply format required on acceptance (4.2.1) of an interrogation is the format denoted by the DF code, which is numerically equal to the UF code of the interrogation, with the exceptions described in the following paragraphs.

4.2.2.1 Replies to Surveillance and Comm-A Interrogations, UF's 4,5,20,21

The reply format required for these interrogations is determined by the code within the RR field, according to the following table:

Uplink format, UF	RR code	Downlink format, DF
4	0 through 15	4
5	0 through 15	5
20	0 through 15	4
21	0 through 15	5
4	16 through 31	20
5	16 through 31	21
20	16 through 31	20
21	16 through 31	21

Note.—In effect, the first bit of the RR field determines the length of the required reply.

4.2.2.2 Interrogation and Reply Formats 24 Through 31

This set of interrogation and reply formats forms the ELM system. Interrogation-reply coordination for these formats is described in 4.11.

4.2.2.3 No Reply

4.2.2.3.1 Broadcast

If an interrogation has been accepted with an All-Call address, but with UF#11 (4.2.1.2), no reply is transmitted.

4.2.2.3.2 UF's 6,22

If an interrogation has been accepted which contains the ground-air coordination UF codes 6 or 22, no reply is transmitted.

4.2.2.3.3 ATCRBS/DABS All-Call Suppression

Suppression as described in ref. A, paragraph 2.7.4 applies to responses to ATCRBS/DABS All-Calls.

4.2.2.3.4 Restricted All-Calls

If an interrogation has been accepted and if the All-Call restriction of 4.12.6 applies, no reply is transmitted.

4.2.2.3.5 Formats for Which Transponder Is Not Equipped

On acceptance (4.2.1) of an interrogation format for which a transponder does not have the required reply capability, no reply is generated.

4.2.3 Reply Delay and Jitter

Note.—After an interrogation has been accepted and if a reply is required, this reply will start after a delay needed to carry out the protocols and transfer of data. Different values for this delay have been assigned for ATCRBS, DABS, and ATCRBS/DABS All-Call replies.

4.2.3.1 ATCRBS Reply Delay and Jitter

The reply delay and jitter for ATCRBS transactions is as prescribed in reference A, 2.7.11.

4.2.3.2 Reply Delay and Jitter for DABS

The leading edge of the first preamble pulse of the reply (2.3.4.2.1) occurs 128 ±0.25 microseconds after the sync phase reversal (2.2.2.3) of the received P6. The jitter of the reply delay does not exceed 0.05 microseconds, rms.

4.2.3.3 Reply Delay and Jitter for ATCRBS/DABS All-Call

The leading edge of the first preamble pusle of the reply (2.3.4.2.1) occurs 128 ±0.5 microseconds after the leading edge of the P4 pulse of the interrogation (2.3.1) and the jitter does not exceed 0.06 microseconds, rms.

Note.—A jitter of 0.06 microseconds, rms, is consistent with the jitter prescribed in ref. A. 2.7.11.

4.3 Lockout Protocol

Note.—Transponders can be prevented from accepting certain interrogations and can be prevented from transmitting squitters (4.4) by command from an interrogator.

4.3.1 Standard All-Call Lockout

On acceptance of an interrogation containing code 1 or 3 in the PC field (3.3.24), a transponder commences to reject (=not accept) two types of All-Call interrogations: a) UF 11 with II=0 and b) the ATCRBS/DABS All-Call of 2.3.1. This lockout condition persists for T_D seconds after the last receipt of the command but can be overridden by the PR codes 8 through 12 (3.3.26).

Note 1.—The value of T_D is given in 5.4.6.
Note 2.—Restricted All-Call lockout is described in 4.12.6.

4.3.2 Squitter Lockout

On acceptance of an interrogation containing code 2 or 3 in the PC field, a transponder ceases to transmit squitters (4.4). This lockout condition persist for T_S seconds after the last receipt of the command.

Note.—The value of T_S is given in 5.4.6.

4.4 Squitter Protocol

Note.—DABS Transponders transmit squitters (unsolicited replies) to facilitate acquisition by active collision avoidance system (BCAS) equipment.

4.4.1 Squitter Format

The format used for squitter transmission is the surveillance reply containing the altitude report, DF 4. The DR code (3.3.9) is set to 0 or 4 to indicate whether the aircraft is BCAS equipped or not.

4.4.2 Squitter Rate

Squitter transmissions are emitted at ramdom intervals with a nominal mean value of one second and a standard deviation of between 0.1 and 0.2 seconds, unless:

a. Squitter lockout (4.3.2) is in effect.

b. A surveillance reply, DF 4 or 20, or BCAS reply, DF 0, has been transmitted in reply to an interrogation in the previous second.

c. The aircraft is on the ground.

d. A reply is required in response to an interrogation.

e. the mutual suppression interface is active (see note below).

A squitter cannot be interrupted by link transactions or mutual suppression activity after the squitter transmission has begun. The transmission of a squitter may be delayed (or made unnecessary in accordance with b. above) by transmission of a reply to an interrogation. The transmission of a squitter may be delayed by mutual suppression activity.

Note.—The mutual suppression system connects all on-board equipment operating in the same frequency band in order to prevent mutual interference.

4.5 Flight Status Protocol

Note.—DABS equipped aircraft report details of their flight status. The source of and the rules for such reports follow.

4.5.1 BCAS Interrogating

A means is available to indicate that the aircraft is equipped with a BCAS unit and that the unit is actively interrogating other aircraft. The appropriate code is transmitted in the FS field (3.3.11).

4.5.2 Alert

The 4096 identification code transmitted in ATCRBS replies and in downlinks DF 5 and DF 21 can be changed by the pilot. When such a change is made, an alert condition is established which may be temporary or permanent.

4.5.2.1 Permanent Alert Condition

If the identification code is changed to 77XX, 76XX or 7500 the alert condition is permanent.

4.5.2.2 Temporary Alert Condition

If the identity code is changed to a value other than those listed in 4.5.2.1, the alert condition is temporary and is self cancelling after 16 ±2 seconds.

4.5.2.3 Reporting of Alert Condition

The alert condition is reported in the FS field.

4.5.2.4 Termination of the Alert Condition

The permanent alert condition is terminated and replaced by a temporary alert condition when the identification code is set to a value other than 77XX, 76XX or 7500.

4.5.3 Ground Report

The DABS transponder has a means for automatic reporting that the aircraft is on the ground. This information is coded in the FS field.

4.5.4 Special Position Identification

When manually selected, an equivalent of the ATCRBS SPI pulse is transmitted by DABS transponders in the FS field of surveillance and Comm-B replies, DF's 4,5,20,21. This code is transmitted for 22 ±7 seconds after initiation and can be reinitiated at any time. See ref. A: 2.6.3 and 2.7.14.

4.6 Capability Reporting

Note:—A DABS installation in an aircraft may be capable of handling a number of aircraft separation or data link services. Aircraft capability is reported in special fields.

4.6.1 Capability Report

The three-bit CA (capability) field, contained in the All-Call reply (DF 11) reports the basic capability of the airborne DABS installation.

4.6.2 Additional Capability Report

A request containing RR=1 elicits an additional capability report from the transponder. This report appears in the UM-field of 3.3.32. Specific codes are not assigned in this Standard.

4.6.3 Extended Capability Report

The extended capability report signals to the interrogator the identity of the possible originators of Comm-B messages or "B-sources" on board the interrogated aircraft. A data request per 4.10.1 containing RR=17 is seen by all B-sources when the transponder delivers the uplink content to them. Each B-source has one bit assigned to it in the extended capability subfield. A non-existing or inoperative B-source cannot set the bit; consequently the active sources are reported.

4.6.3.1 Subfields in MB for Extended Capability Report

EDS: ELM Description, Subfield in MB, 2 bits, 87,88
Coding:
0=No ELM capability
1=Uplink ELM capability
2=Not assigned
3=Uplink and downlink ELM capability
ECS: Extended Capability, Subfield in MB, 16 bits, 71 through 86
Coding:
The reporting bits are assigned such that the bit number is 71+BDS1-number.
BCS: BCAS Capability, Subfield in MB, 1 bit, 70
Coding:
0=BCAS, if reported by bit 77, is "active" type
1=BCAS, if reported by bit 77, is "full capability" type

Note.—The presence of BCAS equipment is reported in ECS bit 77 (see 3.3.28). If there is no BCAS reported, the coding of this subfield has no meaning.

Note.—Structure of MB if BDS1=1

Position	No. of bits	Subfield	Remarks
33 to 36	4	BDS1	=1
37 to 69	33		(1)
70	1	BCS	
71 to 86	16	ECS	
87 to 88	2	EDS	

[1] Not assigned.

4.7 Utility Message Protocol

The Utility Message field (downlink) UM carries either information requested by the interrogator or information volunteered by the transponder.

4.7.1 Requested Information

Information to appear in the subsequent reply is requested by the interrogator by coding the RR field within surveillance or Comm-A interrogations, UF's 4,5,20,21. For coding see 3.3.28.

4.8 Surveillance Data Protocol

Note.—The 16 bit SD field in UF's 4,5,20,21 can be used to transmit short messages.

4.8.1 SD Field Content

Data appearing in the SD field are identified by the code in the DI field. For specific assignments see 3.3.8.

4.8.2 SD Field Coding

Note.—Specific coding details of assigned functions appearing in the SD field are given in 4.12.1.1 and 4.10.1.1.1.

4.9 Comm-A Portocol

Note.—Long uplink messages are contained in the MA field of Comm-A interrogations, UF's 20 and 21.

4.9.1 A-Acknowledgment

Receipt of a message in the MA field is automatically acknowledged by the transponder when the reply to this interrogation is transmitted. In case of uplink failure no reply is transmitted and the interrogator sends the message again. In case of downlink failure, a message may be transmitted to the transponder more than once.

4.9.2 Pilot's Acknowledgment

Note.—If an acknowledgment by the pilot of receipt of a message or command is required, a request to this effect and a code for the positive or negative reply must be part of the internal coding of MA and MB. Pilot operated acknowledgment actuators are not part of the transponder.

4.10 Comm-B Protocol

Note.—Long downlink messages are contained in the MB field of DF's 20 and 21. Information transfer by this field can be ground- or air-initiated. The Comm-B protocol governs the required sequence of events.

The multisite protocol (4.12) can be used with the Comm-B system.

4.10.1 Ground Initiated Comm-B

The interrogator can request data to be read out from any one of up to 14 different sources identified by BDS1 codes. Such readout is initiated by transmitting the appropriate one of the codes 18 through 31 in the RR field of a surveillance or Comm-A interrogation, UF's 4,5,20,21. On receipt of such request, the reply is transmitted containing the data corresponding to the RR code (3.3.28).

Note.—The CIR readout is a ground initiated Comm-B in the sense of this paragraph. If the on-board CIR is not empty it causes the DR field (3.3.9) to be set to 2 or 3. Recognizing this code, the ground then makes a Comm-B request with RR=19 and extracts the data. The protocol for acknowledgment and for further extractions is not part of the transponder and is not included in this Standard.

4.10.1.1 Extended Data Readout

The interrogator can request data to be read out from a source more specifically defined by both BDS1 and BDS2. Such readout is initiated by transmitting, in addition to the BDS1 code (as in 4.10.1), the BDS2 code in the SD field.

4.10.1.1.1 Subfield in SC for Extended Data Readout

The following subfield appears in SD if the DI field is set to 7.

RRS: Reply Request, Subfield in D, 4 bits, 17 through 20

Coding: Corresponding to the requested BDS2 code.

4.10.2 Air Initiated Comm-B

An air initiated Comm-B sequence starts witha the insertion of the code DR=1 or 3 in the DR field of a surveillance or Comm-B reply, DF's 4,5,20,21. On receipt of this "B-code" the interrogator transmits code 16 in the RR field of a subsequent interrogation. Receipt of this code by the transponder constitutes the request to transmit data from the source which initiated the transaction. The resulting MB field contains a BDS code identifying the content of the field. This reply, and others following it, continue to contain the B-code in the DR field. After code 4 (cancellation) is received in the PC field of UF's 4,5,20 or 21, the transaction is cancelled and the B-code in DR is removed.

Note.—This protocol assures transmission and receipt of the message in case of link failure, either up or down.

4.10.3 Loss of DABS Contact

If no interrogation containing the discrete address of the transponder has been received for 16 seconds, loss of DABS contact is assumed and any incomplete transactions are cancelled, and the B-code in DR is removed.

4.11 ELM Protocol

Note.—The extended length message protocol provides for efficient transmission of long messages by permitting the grouping of up to 16 message segments into a single entity which can be acknowledged by a single reply. Uplink segments are called Comm-C and use the UF's 24 through 31, while downlink segments Comm-D and use DF's 24 through 31.

The multisite protocol (4.12) can be used with the ELM system.

4.11.1 Uplink ELM Protocol

Uplink extended length messages are transmitted in segments, each segment formed by a Comm-C format.

In addition to the segment content in MC, two protocol fields, NC and RC are used. NC is the number of the segment transmitted. RC identified the transmission as initial, intermediate or final.

The minimum length of an uplink ELM is two segments. The transfer of all segments may take place without intervening replies. Comm-C transmissions follow each other in intervals of no less than 50 microseconds.

4.11.1.1 Initializing Segment Transfer

The ELM transaction for an n-segment message (NC's 0 through n-1) is initiated by a Comm-C transmission containing RC=0. The text transmitted in MC is stored. The text is the last segment of the message and carries NC=n-1. NC then establishes the number of further segments to be received and to be stored. Receipt of an initializing (RC=0) segment establishes the "setup" in the transponder which is now prepared to accept further segments.

Receipt of another initializing segment results in a new setup within the transponder and causes any previously stored segments to be discarded.

No reply is generated on receipt of an initializing segment.

4.11.1.2 Intermediate Segment Transfer

Intermediate segments are characterized by RC=1 and are accepted and stored only if the setup of the previous paragraphs is in effect.

No reply is generated on receipt of an intermediate segment.

Note.—Intermediate segments may be transmitted in any order.

4.11.1.3 Final Segment Transfer

The final segment is characterized by RC=2, will be accepted under all circumstances and requires a reply. The segment content will be stored.

4.11.1.3.1 Completed Message

The message is completed if all segments announced by NC in the initializing segment have been received. If the message is completed, the message content is delivered to the outside via the ELM interface of 5.5.2.1.3, and the setup is deactivated.

4.11.1.3.2 Acknowledgment Reply

The acknowledgement reply is a Comm-D transmission, with KE=1. KE=1 indicates that within the MD field is the subfield TAS which reports the setup state and summarizes the extent of the segments received.

The information contained in the TAS subfield is continually updated while segments are received and is not cleared until a new initializing segment is received or until closeout (4.11.1.3.4).

Note.—Segments lost in uplink transmission are noted by their absence in the TAS report and are retransmitted by the interrogator which will then send further final segments to assess the situation.

4.11.1.3.3 Subfields for Acknowledgment of an Uplink ELM

The following subfields appear in MD if KE is set to one:

TAS: Transmission Acknowledgment, Subfield in MD, 16 bits, 17 through 32.
Coding: Starting with bit 17, which denotes segment number one, each of the following bits is set to one if the corresponding segment of the message has been received.

4.11.1.3.4 Closeout

A closeout transmission informs the transponder that the TAS has been received and can be cleared. This information, PC=5, is contained in a surveillance or Comm-A interrogation and does not require a special response.

4.11.2 Downlink ELM Protocol

Downlink extended length messages are transmitted only after authorization by the interrogator. The segments to be transmitted are contained in Comm-D replies.

4.11.2.1 Initialization

To request permission to send n segments, the transponder inserts the binary code corresponding to the decimal value 15+n into the DR field of a surveillance or Comm-B reply, DF's 4,5,20,21.

4.11.2.2 Authorization and Transmission

The interrogator requests the transmission of Comm-D segments by a Comm-C interrogation characterized by RC=3. This Comm-C format carries the SRS subfield which is a summary of the segments to be transmitted. On receipt of this authorization the transponder transmits the segments at a rate of one every 136 ±1 microsecond by means of Comm-D formats with KE=O and ND corresponding to the number of the segment in MD. Segments can be transmitted in random order and the message source can be identified by DSS 4.11.2.2.2.

The authorization process may be repeated by the interrogator, indicating segments to be transmitted again.

4.11.2.2.1 Segment Request Subfield

SRS: Segment Request, Subfield in MC, 16 bits, 9 through 24
Coding: Starting with bit 9, which denotes segment number 1, each of the following bits is set to one if the transmission of the corresponding segment is requested.

4.11.2.2.2 D-Source Subfield

DSS: D-Source Subfield in MD, 8-bits, 9 through 16
Coding: This field identifies the source of the Comm-D message and may be used in segment zero of a downlink ELM.

Note: DSS is shown here for convenience; the coding of this field is not included in this Standard.

4.11.2.3 Closeout.

A closeout transmission is used to inform the transponder that all segments have been received and the DR field can be reset. The information, PC=6, is contained in a surveillance or Comm-A interrogation and does not require a special response.

4.12 Multisite Protocols

Note.—Under certain circumstances it may be necessary for multiple DABS sensors which have overlapping coverage in a common geographical region to operate without being in direct communication with each other. When this occurs, conflicting or overlapping requests to the transponder must be avoided. The multisite protocols described in this section provide a means to prevent such conflicts.

4.12.1 Multisite Data Formats

4.12.1.1 Subfields in SD for Multisite Protocols

The following subfields appear in SD if the DI field is set to 1.

IIS: Interrogator Identifier, Subfield in SD, 4 bits, 17 through 20
Coding: Assigned by the interrogator. IIS is echoed in the UM field of the reply and is numerically equivalent to the II field (3.3.13) of the DABS Only All-Call.
IIS numbers range from 1 through 15;
IIS=0 is not a valid interrogator identifier.
MBS: Multisite Comm-B, Subfield in SD, 2 bits, 21 and 22
Coding:
0=no action
1=reservation, Comm-B
2=closeout, Comm-B
3=not assigned
MES: Multisite ELM, Subfield in SD, 3 bits, 23 through 25
Coding:
0=no action
1=reservation, Comm-C
2=closeout, Comm-C
3=reservation, Comm-D
4=closeout, Comm-D
5=reservation Comm-C and closeout Comm-D
6=closeout Comm-C and reservation Comm-D
7=closeout Comm-C and closeout Comm-D
LOS: Lockout, Subfield in SD, 1 bit, 26
Coding:
0=no change in lockout state
1=lockout to DABS-only All-Calls UF=11 from site indicated in IIS
RSS: Reservation Status Request, Subfield in SD, 2 bits, 27 and 28
Coding:
0=no request
1=request Comm-B status in UM
2=request Comm-C status in UM
3=request Comm-D status in UM

Note.—Structure of SD if DI=1

Position	No. of bits	Subfield	Remarks
21 to 22	2	MBS	
23 to 25	3	MES	
26	1	LOS	
27 to 28	2	RSS	
29 to 32	4		(1)

(1) Not assigned.

4.12.1.2 Subfields in UM for Multisite Protocols

The following subfields appear in UM if requested by DI=1 and RSS=0.

IIS: Interrogator Identifier, Subfield in UM, 4 Bits, 14 through 17
Coding: Reserved Interrogator identifier Comm-B, -C, -D, as requested.
IDS: Identifier, Subfield in UM, 2 Bits, 18, 19
Coding:
0=no information
1=IIS contains Comm-B site number
2=IIS contains Comm-C site number
3=IIS contains Comm-D site number

Note.—Structure of UM if DI=1

Position	No. of bits	Subfield	Remarks
14 to 17	4	IIS	
18 to 19	2	IDS	

4.12.2 Multisite Timers

The multisite protocols require three timers in the transponder:

B-timer
C-timer
D-timer

Each timer runs for T_T seconds after starting or restarting and is used for automatic closeout of the respective message type.

Note.—The value of T_T is given in 5.4.7.

4.12.3 Multisite Comm-B Protocol

Note.—The multisite Comm-B protocol augments the standard Comm-B protocol and

when not in use does not modify in any way the process described in 4.10.2.

4.12.3.1 Multisite Comm-B Reservation

When the multisite protocol is in use, an interrogator extracts an air initiated Comm-B by transmitting a surveillance or Comm-A interrogation containing:

RR=16 (read air initiated Comm-B)
DI=1 (multisite SD format)
IIS=Interrogator's site number
MBS=1 Comm-B reservation request)
RSS=1 Comm-B status request)

Transponder action in response to this interrogation depends upon the state of the B-timer:

B-timer not running:
Store IIS for Comm-B
Start B-timer
B-timer running and interrogator's IIS=stored Comm-B IIS:
Restart B-timer
B-timer running and interrogator's IISstored Comm-B IIS:
No change to stored IIS or B-timer

for all three cases, the transponder includes the stored Comm-B IIS in the UM field and the message in the MB field of the reply to this interrogation.

Note.—When an interrogator receives its own site number in the UM of the reply to a multisite Comm-B interrogation, it knows that it is the reserved site for this message and that it should complete the transaction by closing out the message. Other sensors discontinue processing of this message.

4.12.3.2 Multisite Comm-B Closeout

Multisite Comm-B closeout is accomplished using a surveillance or Comm-A interrogation containing:

DI=1 (multisite SD format)
IIS=Interrogator site number
MBS=2 Comm-B closeout)

If IIS of the interrogation equals the stored Comm-B IIS, the stored Comm-B IIS is cleared, the B-timer is stopped and the air initiated message is cancelled. If the site numbers do not match, the message is not cancelled and the states of the stored Comm-B IIS and B-timer are not changed.

4.12.3.3 Automatic Comm-B Closeout

If the transponder B-timer runs out before a multisite closeout is accepted, the stored Comm-B IIS is set to zero to enable this message to be read and cleared by another site.

4.12.4 Multisite Uplink ELM Protocol

Note.—The multisite Comm-C protocol augments the standard Comm-C protocol and when not in use does not modify in any way the standard protocol described in 4.11.1.

4.12.4.1 Multisite Comm-C Reservation

When the multisite protocol is in use, an interrogator makes a reservation for an uplink ELM by transmitting a surveillance or Comm-A interrogation containing:

RR=2 or 16 through 31
DI=1 (multisite SD format)
IIS=Interrogator's site number
MES=1 or 5 (Comm C reservation request)
RSS=2 (Comm C status request)

Transponder action in response to this interrogation depends upon the state of the C-timer:

C-timer not running:
Store IIS for Comm-C
Start C-Timer
C-timer running and interrogator's IIS=Stored Comm-C IIS:
Restart C-timer
C-timer running and interrogator's IIS=Stored Comm-C IIS:
No change to stored IIS or C-timer.

For all three cases, the transponder includes the stored Comm-C IIS in the UM field of the reply to this interrogation.

Note.—When an interrogator receives its own site number in the UM of the reply to a reservation interrogation, it proceeds with the delivery of the uplink ELM. Otherwise, ELM activity is not started during this scan and a new reservation request is made during the next scan.

4.12.4.2 Multisite Comm-C Delivery

After multisite coordination is accomplished via the surveillance or Comm-A interrogation, uplink ELM delivery takes place exactly as described in 4.11.1. In addition, the C-timer is restarted each time that a Comm-C interrogation is received and the stored Comm-C IIS is non-zero.

Note.—The requirement for the stored Comm-C IIS to be non-zero prevents the C-timer from being restarted during a standard uplink ELM transaction.

4.12.4.3 Multisite Comm-C Closeout

Multisite Comm-C closeout is accomplished using a surveillance or Comm-A interrogation containing:

DI=1 (Multisite SD format)
IIS=Interrogator's site number
MES=2, 6 or 7 (Comm-C closeout)

If the stored Comm-C IIS equals the IIS of the interrogator, the uplink ELM is closed out as described in 4.11.1, the stored Comm-C IIS is cleared and the C-timer is stopped. If the site numbers do not match, the message is not cancelled and the states of the stored Comm-C IIS and the C-timer are not changed.

4.12.4.4 Automatic Comm-C Closeout

The closeout actions described in 4.12.4.3 are initiated automatically when the C-timer runs out.

4.12.5 Multisite Downlink ELM Protocol

Note.—The multisite Comm-D protocol augments the standard Comm-D protocol and when not in use does not modify in anyway the standard protocol described in 4.11.2.

4.12.5.1 Multisite Comm-D Reservation

When the multisite protocol is in use, an interrogator makes a reservation for ground initiation of a Comm-D message transfer by transmitting a surveillance or Comm-A interrogation containing:

RR=2 or 16 through 31
DI=1 (Multisite SD format)
IIS=Interrogator's site number
MES=3 or 6 (Comm-D reservation request)
RSS=3 (Comm-D status request)

Transponder action in response to this interrogation depends upon the state of the D-timer:

D-timer not running:
Store IIS for Comm-D
Start D-timer
D-timer running and interrogator's IIS=Stored Comm-D IIS:
Restart D-timer
D-timer running and interrogator's IIS=Stored Comm-D IIS:
No change to stored IIS or D-timer.

For all three cases, the transponder includes the stored Comm-D IIS in the UM field of the reply to this interrogation.

Note.—When an interrogator receives its own site number in the UM of the reply to a reservation interrogation, it proceeds to request delivery of the downlink ELM. Otherwise, ELM activity is not started during this scan and a new reservation request is made during the next scan.

4.12.5.2 Multisite Comm-D Delivery

After multisite coordination is accomplished via the surveillance or Comm-A interrogation, downlink ELM delivery takes place exactly as described in 4.11.2. In addition, the D-timer is restarted each time that a request for Comm-D segments is received if the stored Comm-D IIS is non-zero.

Note.—The requirement for the stored Comm-D IIS to be non-zero prevents the D-timer from being restarted during a standard downlink ELM transaction.

4.12.5.3 Multisite Comm-D Closeout

Multisite Comm-D closeout is accomplished using a surveillance or Comm-A interrogation containing:

DI=1 (Multisite SD format)
IIS=Interrogator's site number
MES=4, 5 or 7 (Comm-D closeout)

If the stored Comm-D IIS equals the IIS of the interrogator, the downlink ELM is closed out as described in 4.11.2, the stored Comm-D IIS is cleared and the D-timer is stopped. If the site numbers do not match, the message is not cancelled and the states of the stored Comm-D IIS and the D-timer are not changed.

4.12.5.4 Automatic Comm-D Closeout

If the D-timer runs out, the stored Comm-D IIS is set to zero. The Comm-D message and the DR field are not cleared. This makes it possible for another site to read and clear the Comm-D message.

4.12.6 Lockout Restrictions

Note.—To prevent transponder acquisition from being denied to one interrogator by lockout commands originating from another interrogator the restricted All-Call lockout is used. (The Standard All-Call lockout 4.3.*1* is independent of this protocol.)

4.12.6.1 Restricted All-Call Lockout Initiation

The restricted lockout command is transmitted in the multisite SD field (4.12.1.1). The command for restricted lockout is indicated by code LOS=1 and the presence of a non-zero site address in the IIS subfield of SD. The restricted lockout persists for an interval T_D after the last acceptance of an interrogation containing the restricted lockout command.

Note.—Fifteen interrogators can send independent restricted lockout commands. Each of these must be timed independently.

4.12.6.2 Restricted All-Call Lockout Function

After a transponder has accepted an interrogation containing a restricted lockout command, that transponder rejects all DABS-Only All-Call interrogations which include the site number of the interrogator that commanded the lockout.

Note.—Restricted lockout does not affect the response of the transponder to DABS-Only All-Call interrogations with II=0.

4.13 Flight Identification Reporting

A data request per 4.10.1 containing RR=18 elicits a reply containing the flight identification in the MB field of the resulting reply.

4.13.1 Subfield in MB for Flight Identification

FIS: Flight Identification, subfield of MB, 42 bits, 47 through 88. Coding not yet determined, see note at 5.5.1.1.

Note.—Bits 41 through 46 are not assigned.

4.14 Broadcast Protocol

The content of broadcast interrogations (4.2.1.2 and 4.2.2.3.1) is presented at the data interface of the transponder but does not otherwise affect the operation of the transponder.

Note.—Although it is possible to transmit surveillance and Comm-A interrogations with a broadcast address, this is not anticipated. This paragraph prevents protocol (lockout) changes if broadcast should be used.

4.15 Synchronized Transmission Protocol

Synchronized surveillance transmissions use the uplink and downlink formats UF=DF=2,18. The EP (epoch) field and the six bits following it in a received synchronized interrogation are echoed by the transponder in the corresponding reply.

4.16 All-Call Reply Protocol

The DABS-only All-Call interrogation UF 11 contains the interrogator identifier in the II field. The content of this field is replicated and is overlid on parity according to 4.1.2, resulting in the PI field of the reply DF11.

Receipt of an ATCRBS/DABS All-Call interrogation automatically implies that the interrogator identifier is zero.

4.17 BCAS Protocol

BCAS uses the uplink and downlink formats UF/DF=0 and 16.

4.17.1 AQ Protocol

See 3.3.4.

4.18 ATARS/CIR Protocol

ATARS and CIR control codes contained in the SD and RR fields define data to be contained in the UM and MB fields respectively of the corresponding replies. Coding and protocol are not included in this Standard.

5. Transponder Characteristics

This section describe the technical characteristics of the DABS transponder.

5.1 Interrogation Acceptance Criteria

DABS transponders accept ATCRBS mode A and mode C interrogations in accordance with the provisions of ref. A with the following exception: DABS transponders do not accept a waveform as an ATCRBS interrogation if the P_3 pulse is followed by a valid P_4 pulse (2.3.1). However, if a valid ATCRBS waveform is followed by a pulse with a leading edge within the P_4 acceptance interval (5.1.1.2) but:

a. the duration of said pulse is less than 0.3 microsecond *or*

b. the level of said pulse is more than 6 dB below the level of P_3, the waveform is accepted by the DABS transponder as an ATCRBS interrogation.

Note.—The DABS transponder does not generate a reply of any type on receipt of an ATCRBS-only All-Call interrogation (short P_4). This allows DABS transponders to be removed from the ATCRBS reply population in synchronous garble situations. The DABS transponder generates a DABS reply on receipt of an ATCRBS/DABS All-Call interrogation (long P_4).

5.1.1 DABS Interrogation Acceptance

5.1.1.1 Pulse Level Tolerances

DABS transponders do not accept a waveform as an ATCRBS/DABS All-Call (2.3.1) if the level of the pulse in the P_4 position is more than 6 dB below the level of P_3.

5.1.1.2 Pulse Position Tolerances

DABS transponders do not accept a waveform as an ATCRBS/DABS All-Call (2.3.1) if a P_4 leading edge is not detected within the interval from 1.7 to 2.3 microseconds following the leading edge of P_3.

Note.—The effect of this paragraph is that the DABS transponder does not generate an All-Call reply on receipt of an ATCRBS interrogation with a wide P_3 pulse. However, the DABS transponder may generate the appropriate ATCRBS reply to such an interrogation.

5.1.1.3 Pulse Duration Tolerances

DABS transponders do not accept a waveform as an ATCRBS/DABS All-Call (2.3.1) if the duration of the P_1 or the P_3 pulse is less than 0.3 microsecond or if the duration of the P_4 pulse is less than 1.2 microsecond.

5.1.1.4 Sync Phase Reversal Position Tolerance

DABS transponders do not accept a waveform as a DABS interrogation if the sync phase reversal (2.3.2) is not detected in its assigned interval ± nanoseconds.

5.2 Transponder Sensitivity and Dynamic Range

Transponder sensitivity is defined in terms of a given signal input level at the antenna terminal of the installation and a given percentage of corresponding replies. Only correct replies containing the prescribed bit pattern for the interrogation received are to be counted. Given an interrogation which requires a reply according to 4.2, the minimum triggering level, MTL, is defined as the minimum input power level for at least 90% reply to interrogation ratio. The reply to interrogation ratio of a DABS transponder is:

a. at least 90% at MTL, which is −74 dBm ±3 dB

b. at least 99% for signal input levels between (MTL + 3 dB) and −24 dBm

c. no more than 10% at signal input levels below −81 dBm

Note.—Transponder sensitivity as well as output power are described in this document in terms of signal level at the terminals of the antenna. This gives the designer freedom to arrange the installation, compromising between cable length and receiver-transmitter design and does not exclude the

transmitter output stage from becoming an integral part of the antenna subassembly.

5.2.1 Sensitivity in the Presence of Interference

Note.—The principal interfering signals in space are ATCRBS waveforms. Since the technical characteristics of these signals are well defined, DABS transpowers can be designed to be as immue to them as possible. The use of the DPSK modulation scheme on the uplink provides inherent interference rejection capability. Proper design of the DABS decoder provides additional immunity to false mode decodes. The following paragraphs present measures of the performance of the DABS transponder in the presence of common interference signals.

5.2.1.1 Reply Ratio in the Presence of a Standard Interfering Pulse

A standard interfering pulse is defined as a 0.8 microsecond pulse of 2.2.1.1 with a carrier frequency of 1030 ±0.2 MHz which is incoherent with the DABS signal of the test and which overlaps the P_6 of the DABS interrogation anywhere after a point 0.5 microseconds following the sync phase reversal.

Given an interrogation which requires a reply (4.2), the reply ratio of a transponder is at least 95 percent if the level of the interfering pulse is 6 dB or more below the signal level for input signal levels between −68 and −24 dBm.

Under the same conditions the reply ratio is at least 50 percent if the interference pulse level is 3 dB or more below the signal level.

Note.—This test simulates the overlay of ATCRBS pulses over the DPSK modulation of the DABS interrogation and assures that the demodulation scheme of the transponder is effective. Designs such as narrow band filters which merely detect the occurrence of a phase change will not pass this test.

5.2.1.2 Reply Ratio in the Presence of Pulse Pair Interference

The interfering signal consists of P_1 and P_2, spaced 2 microseconds apart with a carrier frequency of 1030 ±0.2 MHz which is incoherent with the DABS signal of the test. The interfering pulse pair overlays any part of the DABS interrogation except that the leading edge of the P_1 interfering pulse occurs no earlier than the P_1 pulse of the DABS signal. Given an interrogation which requires a reply (4.2), the reply ratio of a transponder is at least 90 percent if the level of the interfering signal is 9 dB or more below the signal levels for signal level inputs between −68 and −24 dBm.

Note.—This assures that DABS decoding is not inhibited by the receipt of ATCRBS sidelobe suppression pulse pairs.

5.2.1.3 Reply Ratio in the Presence of Low Level Asynchronous Interference

For all received signal levels between −65 dBm and −27 dBm (measured at the antenna terminal of the installation) and given interrogations which have to be accepted and replied to (4.2) and if no lockout condition is in force, the transponder replies correctly with at least a 95 percent reply ratio in the presence of asynchronous interference. Asynchronous interference consists of single 0.8-microsecond pulses with carrier frequency of 1030 ±0.2 MHz, incoherent with the DABS signal carrier frequency and occurring at all repetition rates up to 10,000 Hz at a level 12 dB or more below the level of the DABS signal. The reply ratio under the same conditions is more than 98 percent if the asynchronous interference signal consists of P_1–P_2 pulse pairs where the P_1 and P_2 amplitudes are equal.

Note.—This test simulates the situation which occurs when stray pulses are received before the DABS waveform so that the combination of a stray pulse with the P^1 of the DABS interrogation forms a valid ATCRBS format. If the ATCRBS mode decoder is designed properly, ATCRBS acceptance will be declared only for a narrow range of P_1 to psuedo-P_2 spacing.

5.3 Transponder RF Peak Output Power

The rf peak output power at the terminals of the antenna is:

Minimum rf power for aircraft incapable of flying above 15,000 ft: 18.5 dBW
Minimum rf power for aircraft capable of flying above 15,000 ft: 21.0 dBW
Maximum rf power for all aircraft: 27.0 dBW

5.3.1 Unwanted Transponder Output Power

When the transponder transmitter is in the off state, the RF output power in the frequency band from 1087 to 1093 MHz at the terminals of the antenna does not exceed −40 dBm.

Note.—Off-state transponder power is constrained in this way to insure that an aircraft when located very near an ATCRBS or DABS sensor (as close as 500 ft.) does not cause interference to that installation. In certain applications of DABS, BCAS for example, in which the distance between the 1090 MHz transmitter and an on-board 1090 MHz receiver can be even smaller, it may be desirable to further constrain the off-state transponder RF power.

5.4 Special Characteristics

5.4.1 Dead Time

Dead time is the time interval beginning at the end of a reply transmission and ending when the transponder has regained its full sensitivity. Transponders do not have more than 125 microseconds dead time.

Note.—Transponders should have a minimum of dead time to maximize system round reliability.

5.4.2 Recovery Time

Recovery time is the time interval beginning at the end of a received signal and ending when the transponder has regained its full sensitivity, provided that no reply is being made in response to the received signal.

5.4.2.1 ATCRBS Recovery Time

All transponder recovery times related to ATCRBS interrogations are as prescribed in ref. A.

5.4.2.2 DABS Receiver Desensitization

On receipt of any pulse of more than 0.7 microsecond duration, the transponder's receiver is desensitized according to ref. A, 2.7.7.1.

5.4.2.3 Recovery From a DABS Interrogation

Following a DABS interrogation which either has not been accepted (4.2.1) or for which a reply will not be generated (4.2.2.3) a transponder recovers sensitivity at the rate described in ref. A, 2.7.7.2.

5.4.2.4 Recovery From a Single Pulse

If a P_2 pulse is not received following a single pulse meeting the specifications for a DABS P_1 pulse, transponders recover sensitivity at the rate described in ref. A, 2.7.7.2.

5.4.2.5 Recovery From an ATCRBS Suppression Pair

ATCRBS suppression is in effect following the receipt of a P_1–P_2 suppression pair. If a DABS P_6 is not detected following that pair, then the transponder recovers sensitivity as described in ref. A, 2.7.7.2. ATCRBS suppression pairs do not otherwise interfere with the reception of DABS interrogations.

5.4.3 Unwanted DABS Replies

In the absence of valid interrogation signals, DABS transponders do not generate unwanted DABS All-Call replies more often than once per 100 seconds and do not generate unwanted DABS discrete replies more often than once per 100,000 seconds.

Note.—An unwanted DABS All-Call reply may occur due to the decoding of receiver noise and adds to the interference on the beacon reply channel. The occurrence of an unwanted DABS discrete reply implies that the signal causing the spontaneous reply may have also caused an unwanted data transfer at the data output port which could lead to the presentation of erroneous air traffic

control advisories on cockpit display equipment.

5.4.4 Reply Rate Limiting

5.4.4.1 ATCRBS Reply Rate Limiting

ATCRBS reply rate limiting is implemented in accordance with ref. A, 2.7.10.1 and 2.7.10.3

5.4.4.2 DABS Reply Rate Limiting

DABS replies and squitters may be included along with ATCRBS replies as part of the total reply count used to determine the receiver sensitivity for ATCRBS reply rate limiting specified in 5.4.4.1. It is permissible for the sensitivity to DABS interrogations to be reduced when ATCRBS reply rate limiting is in effect. If the ATCRBS reply rate limit is not exceeded and when the dead time (5.4.1) and recovery time (5.4.2.) rules are not violated, the transponder is capable of replying to all combinations of ATCRBS and DABS interrogations for which the transmitter duty cycle is not greater than 2 percent, averaged over a 100 millisecond period, exclusive of Comm-D bursts.

5.4.5 DABS Peak Reply Rate

At least once every four seconds a DABS transponder is capable of transmitting six short (56 bit) or three long (112 bit) DABS replies in each of five consecutive 5 millisecond intervals.

5.4.5.1 DABS ELM Peak Reply Rate

At least once every four seconds a DABS transponder equipped for ELM downlink operation is capable of transmitting, in a 25-millisecond interval, 25% more segments than has been announced in the initialization (4.11.2.1).

Note.—Transponders may exist which are capable of transmitting less than the maximum allowable number of Comm-D segments in one burst. The requirement for 25% surplus transmitting capacity is derived from the possible need for reinterrogation.

5.4.6 Lockout and Lockout Duration

DABS transponders follow the lockout and reply restriction protocol (4.3). Durations T_D and T_S are 16 $\pm$2 seconds. For the multi-site lockout protocol (4.12.6), each individual lockout timer also has a 16 $\pm$2 second duration.

5.4.7 Multisite Timer Duration

DABS transponders follow the multisite protocol (4.12) and have at least one multisite timer, the B-timer. DABS transponders equipped for ELM operation also incorporate the C and D-timers. In all cases, Durations T_T are 32 $\pm$2 seconds.

5.5 Data Handling and Interfaces

5.5.1 Direct Data

Direct data are those which are part of the surveillance protocol of the DABS system.

5.5.1.1 Fixed Direct Data

Fixed direct data characterize the aircraft and are:

a. The DABS address (3.3.1, 4.2.1.1) if fixed; see Note 2

b. The maximum airspeed (3.3.5.2.1)

c. The flight identification data (4.13)

Note 1.—The flight identification number for some aircraft is the "Tail Number" or registration number of the aircraft. This number is used in communication with air traffic control and it never changes. It is thus classified as "fixed direct data". Other aircraft report their "flight number" rather than their registration number. The flight number changes frequently and is thus classified as "variable" direct data (5.5.1.3). Coding for the DABS address and the flight identification data is not included in this Standard.

Note 2.—In certain circumstances aircraft may have a variable address. In such cases the rules of 5.5.1.4 apply.

5.5.1.2 Interfaces for Fixed Direct Data

Interfaces from the transponder to the aircraft are provided such that the values of the fixed direct data become a function of the aircraft installation rather than of transponder configuration.

Note.—The intent of this paragraph is to encourage a connector system which permits transponder exchange without manipulation of the transponder itself for setting the fixed direct data.

5.5.1.3 Variable Direct Data

Variable direct data characterize the flight condition of the aircraft and are:

a. the pressure altitude (3.3.2)

b. the 4096 identification code (3.3.12)

c. the "on the ground" condition (3.3.11) and 3.3.5.2.1)

d. the flight identification data number (4.13) (also see note at 5.5.1.1)

e. the SPI condition (3.3.11)

5.5.1.4 Interfaces for Variable Direct Data

The 4096 identification code, the SPI condition, the FR condition, and the variable flight identification data or "flight number" values are inserted by the pilot.

An interface to accept the pressure altitude code is included. The "on the ground" condition is reported by an "air-ground"sensor; the DABS transponder has an input port for this purpose.

Note.—A specific interface design for the variable direct data is not prescribed in this Standard.

5.5.2 Indirect Data

Indirect data are those which pass through the transponder in either direction but which do not affect the surveillance protocol.

5.5.2.1 Indirect Data Interfaces

One or more indirect data interfaces are required if information is transferred to or from devices outside of the transponder.

Note.—Detailed interface descriptions are not included in this Standard.

5.5.2.1.1 The Uplink Interface

If the transponder transfers the content of received interrogations to one or more devices on board the aircraft, the following conditions must be met:

1. The content of the transfer must include all of the uplink transmission except the last 24 bits.

2. The interface must be capable of transfering the content of a new interrogation every 400 microseconds.

Note.—The full content of the uplink transmission is needed for identification of the content of the data fields.

5.5.2.1.1.1 Integrity of the Uplink Content Transfer

If an uplink interface (5.5.2.1.1) is employed it must include sufficient protection to assure error rates of less than one error in 10^3 messages and less than one undetected error in 10^7 messages between the transponder and the peripheral device(s) in an operational aircraft environment.

Note.—A very low undetected message error rate is required because of the critical nature of the information to be transferred for separation assurance services. Aircraft separation assurance display devices will reject messages which are detected to be in error.

5.5.2.1.2 The Downlink Interface

If information originating in certain peripheral devices (BCAS/ATARS/CIR) is to be transmitted by the transponder, the interface must be able to insert bits or bit patterns at appropriate locations within the transmission. These locations do not include the locations of bit patterns generated by the transponder internally or of the address/parity field of the reply.

Note.—Examples are the content of the DR, FS and UM fields.

If information is to be transmitted by the transponder using the Comm-B format, the B-protocol (4.10) requires immediate access to requested data in the sense that the transponder must respond to an interrogation with data requested by that interrogation. This

requirement can be met in either of two ways:

a. the transponder may have provisions for internal data buffering,

b. the transponder may employ a "real time" interface which operates such that uplink data leave the transponder before the corresponding reply is generated and downlink data enter the transponder in time to be incorporated in this reply.

Note.—The DABS transponder may include an interface provision for supporting ATARS and BCAS. In addition to transfer of data to a cockpit display, these aircraft separation services require the transfer of data to and from a Conflict Indicator Register (CIR). If the CIR is not an integral part of the transponder, the data interface must operate in real time so that the transponder can respond to an interrogation with CIR information designated by the contents of that interrogation.

5.5.2.1.3 The Extended Length Message Interface

The ELM interface extracts from and enters into the transponder the data exchanged between air and ground by means of the ELM protocol (4.11). ELM messages employ bursts of Comm-C and Comm-D transmissions and therefore the message contents must be buffered within the transponder.

5.5.2.2 Indirect Data Transaction Rates

5.5.2.2.1 Standard Transactions

A DABS transponder is capable of handling the data of at least 30 short or long interrogations and the data of at least 15 long replies in a four-second period with all transactions arbitrarily spaced within a single 25 millisecond interval.

Note.—This corresponds to the DABS peak reply rate prescribed in 5.4.5.

5.5.2.2.2 ELM Transactions

If equipped for ground-to-air ELM operation, a DABS transponder can handle the data of at least one complete 16-segment ELM (4.11.1). If equipped for air-to-ground ELM operation, a DABS transponder can handle at least one 4-segment air-to-ground ELM (see 5.4.5.1 and 4.11.2.2).

6. Transponder Antenna System

6.1 Antenna Polarization

Vertical polarization is used.

6.2 Antenna Coverage

The transponder antenna system, when installed on an aircraft, provides transmit and receive gain of −10 dB or more with respect to isotropic over at least 90% of a nominal coverage region 70 degrees above and 70 degrees below the horizontal plane of the aircraft for all azimuth angles. In addition, the antenna system provides multipath immunity and does not adversely affect ground surveillance reliability.

7. Interrogator Characteristics

This section describes salient technical characteristics of the DABS interrogator.

Note.—To assure that DABS interrogator action is not injurious to the radar beacon system, performance limits exist for DABS interrogators.

7.1 Interrogation Repetition Rates

DABS interrogators use the lowest practicable interrogation repetition rates for all interrogation modes.

7.1.1 ATCRBS/DABS All-Call Interrogation Repetition Rate

The interrogation repetition rate for the ATCRBS/DABS All-Call, used for acquisition, is less than 150 per second.

7.1.2 Interrogation Repetition Rate to a Single Aircraft

DABS interrogations requiring a reply are transmitted to a single aircraft in intervals not shorter than 400 microseconds.

7.1.3 Repetition Rate for Discrete Interrogations

The interrogation rate for DABS uplink formats is:

a. less than 1165 per second averaged over a 4 second interval

b. less than 1840 per second averaged over a 1 second interval

c. less than 2400 per second averaged over a 40 millisecond interval

Note.—The interrogation rate above depends on the number of DABS transponders within the coverage volume of the interrogator. If there are no DABS transponders in this volume, the interrogation rate is zero. The rates given above are based on the following assumptions considering absolute worst-case traffic loading and bunching for a rotating antenna interrogator with a 4 second/360° scan rate:

	Number of DABS aircraft	Interrogations per aircraft	Total number of interrogations	Period	Rate (sec^{-1})
Scan angle:					
360°	700	3 long	2,100		
	+160	16 ELM	2,560		
Total			4,660	4 sec	1,165
90°	400	3 long	1,200		
	+40	16 ELM	640		
Total			1,840	1 sec	1,840
3.6°	48	2 long	96	0.04 sec	2,400

7.2 Interrogator RF Peak Output Power.

The maximum effective radiated peak power of all interrogation pulses is as described in ref. A, 2.8.2.1.

Note.—Ref. A permits up to 52.5 dBW which includes antenna gain and transmission losses.

7.3 Unwanted Interrogator Output Power.

When the interrogator transmitter is in the OFF state, its output in the frequency band from 1027 to 1033 MHz does not exceed −15 dBW effective radiated power.

Note.—This constraint assures that aircraft flying near the interrogator (as close as 1 nmi) do not receive interference that would prevent their being tracked by another interrogator. In certain instances even smaller interrogator-to-aircraft distances are of significance, for example if DABS surveillance on the airport surface is used. In such cases a further restraint on off-state interrogator output power may have to be used.

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